Dynamic behavior of rotating magnetic field perturbation induced by the dynamic ergodic divertor in the TEXTOR tokamak

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The dynamic behavior of rotating helical magnetic field perturbation at scrape off layer (SOL) has been studied by analyzing the phase difference ($\Delta\phi$) between H_α intensity and the coil current of the dynamic ergodic divertor (DED) in TEXTOR. The interacting position between plasma and a limiter or a divertor tile shifts according to the helical rotation of the magnetic field perturbation. The H_α intensity is also perturbed due to the plasma-wall interaction. So, the change in $\Delta\phi$ should correspond to the behavior of the magnetic perturbation field.

The H_α intensities are measured at poloidal limiters (PL), an ALT-II tile (AL) and a DED tile (DT). The value of $\Delta\phi$ is obtained by using a cross spectrum between signals of the H_α intensity and the DED coil current.

The counter-rotating DED with its mode of m/n=3/1 at 1kHz AC is applied to NBI (300 kW) heated plasma (B_T = 2.25 T, I_p = 300 kA and $\bar{n}_e$ = 2.0 x 10^{19} m^{-3}) and the amplitude of the DED coil current is ramped up to 2.0 kA. At the threshold of a DED coil current (~1.6 kA), m/n=2/1 tearing mode is exited and the mode is locked to the DED perturbation. At that time, $\Delta\phi$ at each position decreases. Under the definition of the cross spectrum, the decrease in $\Delta\phi$ means that the rotation of the perturbation field draws back in the opposite direction. When ECRH with the power of 800 kW is applied after the mode onset and the 2/1 tearing mode is suppressed, $\Delta\phi$ recovers to the former value.

The electron density is increased from 2 x 10^{19} m^{-3} to 4 x 10^{19} m^{-3} during the co-rotating DED with its mode of m/n=3/1 at 1kHz AC. As the electron density increases, $\Delta\phi$ at PL and AL increases and that of DT does not change probably due to an effect of near field. This means that the rotation of the perturbation field at SOL advances with increase in the density. It may be attributed to the change in the diamagnetic frequency due to the density increase.